

The Greenhouse Effect on Natural Systems

California Education and the Environment Initiative

Approved by the California State Board of Education, 2010

The Education and the Environment Curriculum is a cooperative endeavor of the following entities:

California Environmental Protection Agency
California Natural Resources Agency
Office of the Secretary of Education
California State Board of Education
California Department of Education
California Integrated Waste Management Board

Key Leadership for the Education and Environment Initiative:

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Key Partners:

Special thanks to **Heal the Bay,** sponsor of the EEI law, for their partnership and participation in reviewing portions of the EEI curriculum.

Valuable assistance with maps, photos, videos and design was provided by the **National Geographic Society** under a contract with the State of California.

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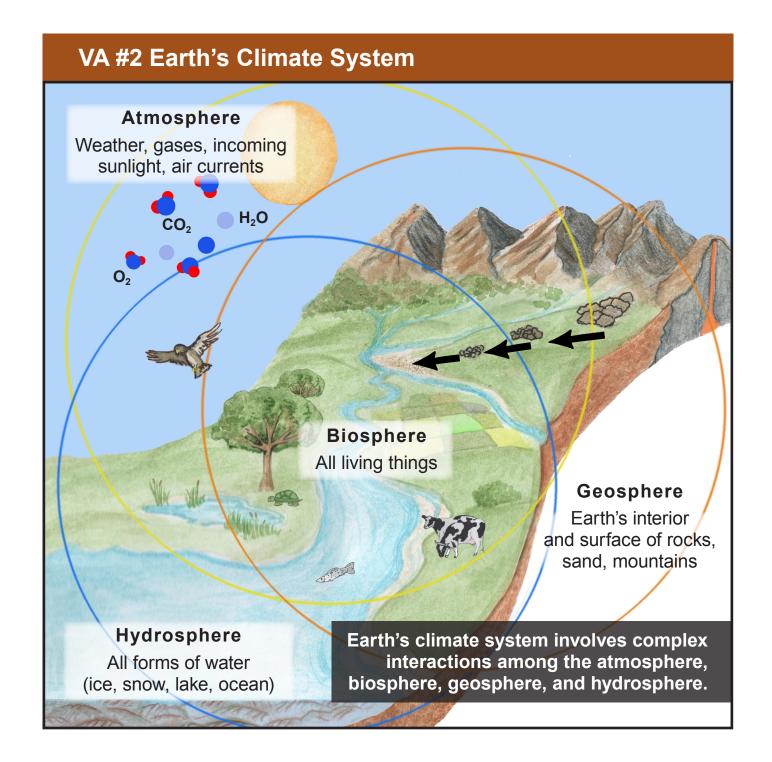


L	esson 1 Climate, A Changing Environment
1	California 18,000 Years Ago
2	Earth's Climate System
L	esson 2 Earth's Greenhouse
3	Atmospheres of Earth, Venus, and Mars
4	A Greenhouse 5
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11	Historical Sea-Levels for San Francisco and San Diego
12	Projected Global Warming Effects in California

Lesson 6 Deciding About the Atmosphere

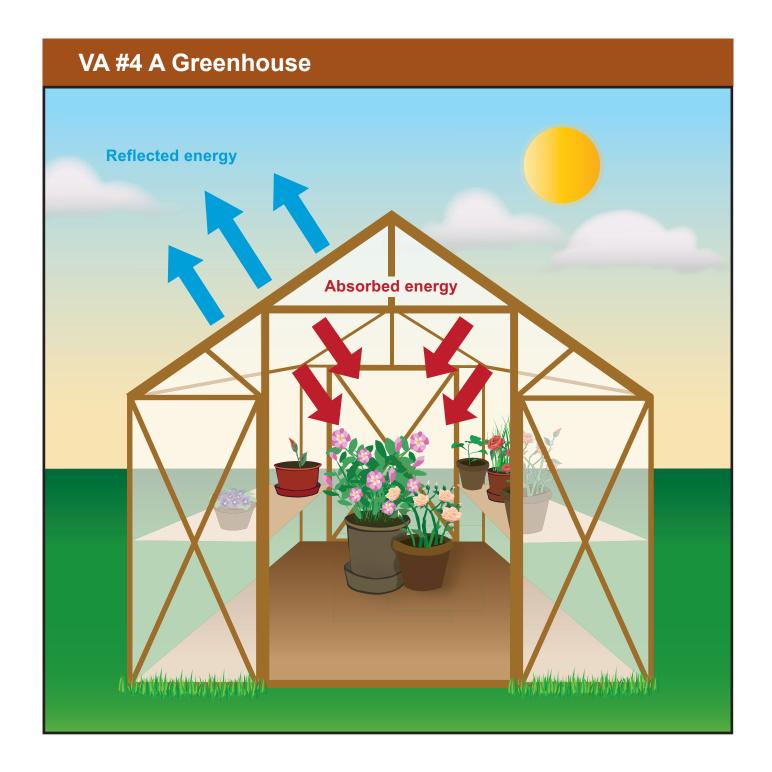
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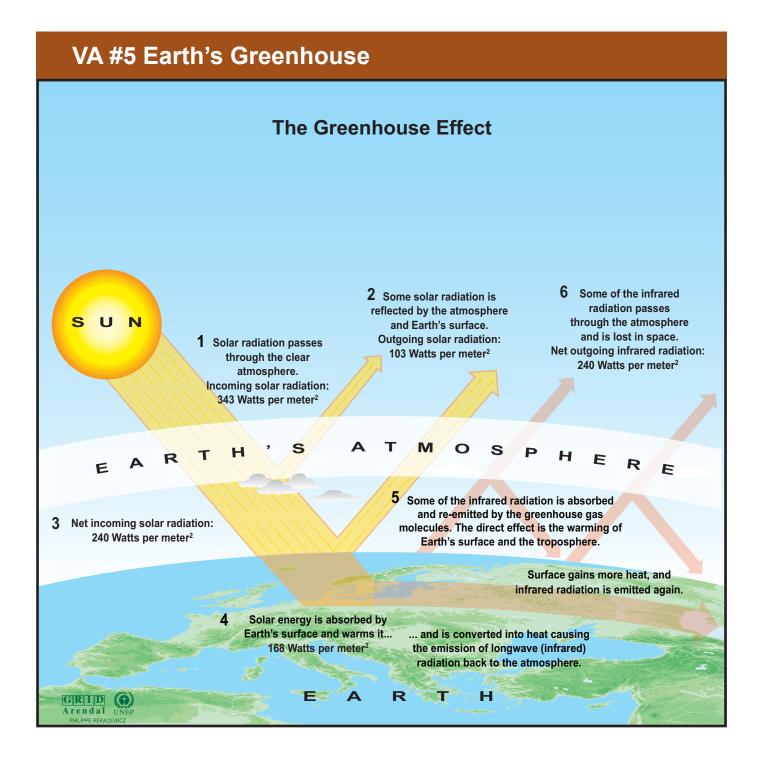




VA #3 Atmospheres of Earth, Venus, and Mars

	Earth	Venus	Mars
Carbon Dioxide (CO ₂)	0.030 %	96.500 %	95.000 %
Nitrogen (N ₂)	78.000 %	3.500 %	2.700 %
Oxygen (O ₂)	21.000 %	Trace	0.130 %
Argon (Ar)	0.900 %	0.007 %	1.600 %
Methane (CH ₄)	0.002 %	0 %	0 %
Nitrous Oxide (NO ₂)	Yes	No	Yes
Water Vapor	Yes	No	No





VA #6 San Luis Reservoir, California

VA #7 Other Greenhouse Gases

Chlorofluorocarbons (CFCs, HCFCs) Hydrofluorocarbons (HFCs) Perfluorocarbons (PFCs)









Found in aerosol sprays (spray paint, cooking spray), dry cleaning fluids, air conditioning, refrigeration, and medical supplies.

Sulfur hexafluoride (SF₆) Nitrogen trifluoride (NF₃)

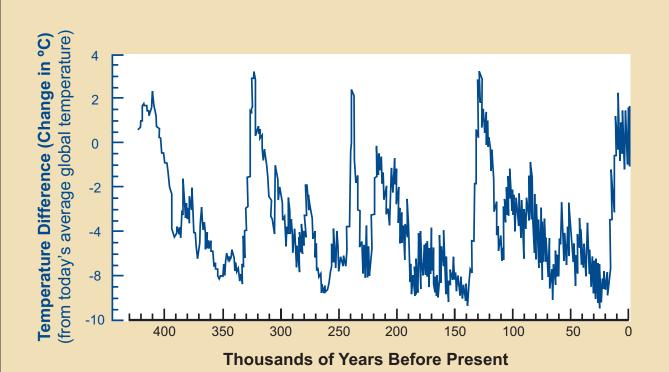




Used in electronics, as well as processing and manufacturing of semiconductors, like solar panels.

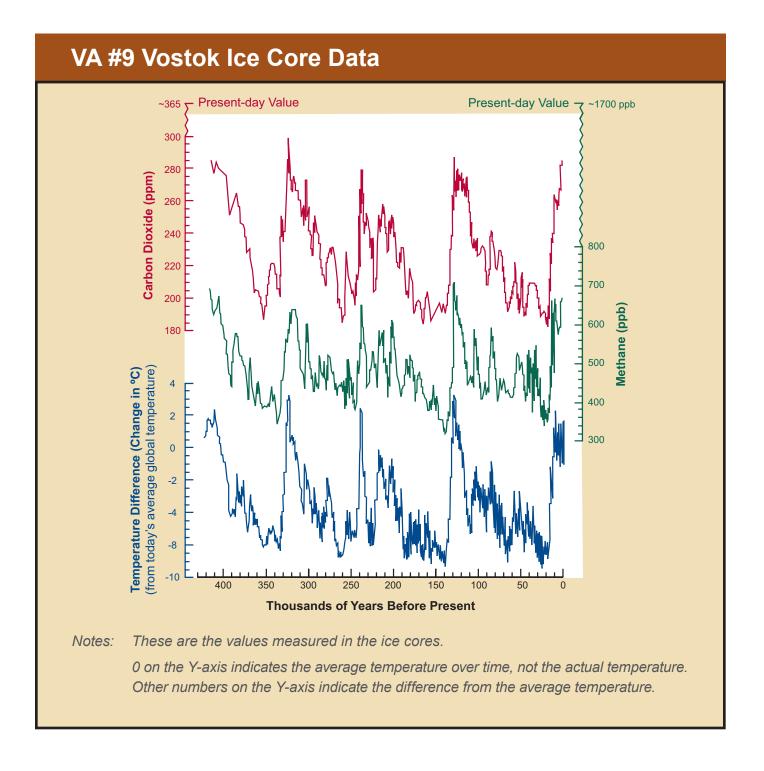
Sources of these GHGs: Human activity (only) Sinks of these GHGs: The atmosphere (only)

VA #8 Temperature Change on Earth Over Time



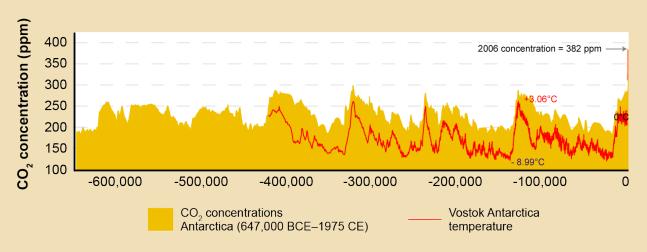
Notes: These are the values measured in the ice cores.

> 0 on the Y-axis indicates the average temperature over time, not the actual temperature. Other numbers on the Y-axis indicate the difference from the average temperature.



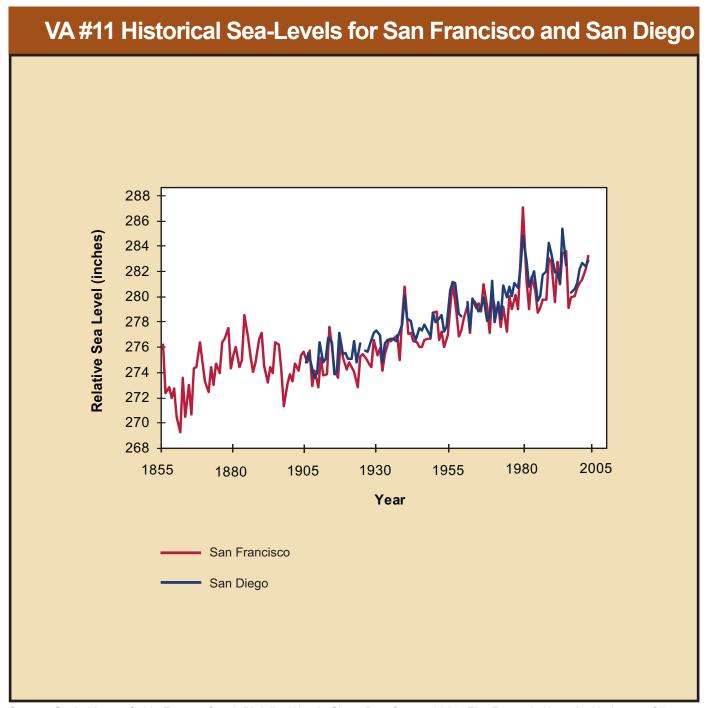
VA #10 Antarctic Temperatures and Atmospheric CO₂

CO₂ concentrations 647,000 BCE to 2006 CE Antarctic temperature 421,000 BCE to 2000 CE



*Antarctic temperature is measured as the change from the average conditions for the period 1850 CE-2000 CE

Source: U.S. Environmental Protection Agency (2009) http://www.epa.gov/climatechange/science/pastcc.html



Source: Susie Moser, Guido Franco, Sarah Pittiglio, Wendy Chou, Dan Cayan, 2009. The Future Is Now: An Update on Climate Change Science Impacts and Response Options for California. (California Energy Commission, PIER Energy-Related Program, CEC-500-2008-071)

VA #12 Projected Global Warming Effects in California Summary of Projected Global Warming Effects, 2070–2099 (as compared with 1961–1990) 13° F 90% loss in Sierra snowpack · 22-30 inches of sea level rise 12 • 3-4 times as many heat wave days in major urban centers • 4-6 times as many heat-related deaths in major urban centers · 2.5 times more critically dry years Higher • 20% increase in energy demand **Warming Range** Higher (8-10.5° F) **Emissions** • 70-80% loss in Sierra snowpack Scenario • 14-22 inches of sea level rise • 2.5-4 times as many heat wave days in major urban centers • 2-6 times as many heat-related deaths in or urban centers Medium-Medium • 75-85% increase in days conducive to ozone formation* Warming Range High • 2-2.5 times more critically dry years **Emissions** $(5.5-8^{\circ} F)$ • 10% increase in electricity demand Scenario • 30% decrease in forest yield (pine) • 55% increase in the expected risk of large wildfires Lower **Emissions** Scenario Lower • 30-60% loss in Sierra snowpack Warming Range • 6-14 inches of sea level rise $(3-5.5^{\circ} F)$ • 2-2.5 times as many heat wave days in major urban centers • 2-3 times as many heat-related deaths in major urban centers • 25-35% increase in days conducive to ozone formation* • Up to 1.5 times more critically dry years • 3-6% increase in electricity demand 7-14% decrease in forest yields (pine) 10-35% increase in the risk of large wildfires *For high ozone locations in Los Angeles (Riverside) and the San Joaquin Valley (Visalia)

Source: Union of Concerned Scientists (2006) http://www.climatechoices.org/impacts_overview/





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